

REMARKS

Claims 1-20 are pending. Favorable reconsideration is respectfully requested.

At the outset, Applicants thank Examiner Uhler for helpful comments in the Office Action to help overcome the rejections in the present application.

The rejection of Claims 1-4 under 35 U.S.C. § 102(b) over Parent is obviated by the above amendment. Further, Parent fails to disclose or suggest the claimed powder which does not contain an element selected from an alkali metal.

Parent discloses, at best, aluminum nitride (AlN) produced by a carbothermal-reaction using an alkali metal oxide (see column 2, lines 52-54). Further, Parent only discloses using a conventional batch type operation to produce AlN (see Examples 1-3). Due the Parent's explicit disclosure regarding the preferences for alkali metal oxide in its batch type carbothermal-reaction (see column 2, line 66, to column 3, line 53), it appears as if the resultant powder inherently contains the added alkali metal, which may produce crucial crystal lattice defects that tend to degrade thermal conductivity of the resultant product. Further, remaining alkali metals may not be desired for their well-known high reactivity with silicon, resulting in instability. Finally, the conventional batch type production process may produce low yields.

In direct contrast, the claimed powder contains Al, O, and N, or Al and N (See Claim 1). Further, the claimed powder does not contain an alkali metal (See Claim 1). Further, the claimed powder is not produced with a conventional batch type production process (see Claim 1). Therefore, Parent fails to disclose or suggest the claimed powder. In fact, Parent appears to teach away from the claimed powder with its disclosure regarding the positive impact of alkali metals within its disclosed process (see column 2, line 66, to column 3, line 53). Accordingly, withdrawal of this ground of rejection is respectfully requested.

The rejection of Claim 3-5 under 35 U.S.C. § 112, second paragraph, is obviated by the above amendment. More specifically, Claim 1 has been amended so that “the raw material” in Claims 3 and 4 now has proper antecedent basis. Further, Claim 3 does not contain the recitation “perfect combustion ratio”. However, Claim 2 contains the recitation “perfect combustion ratio” which is recognized in the art to mean that in which the proportion of carbon and oxygen is 1:2 (e.g. CO₂). Finally, the claims have been amended to clarify that the raw material may be either a powder consisting of element Al, or the raw material may be a mixture of a powder consisting of elements Al and O and a powder consisting of element C. Accordingly, withdrawal of these grounds of rejection is respectfully requested.

The objection to Claims 5 and 7 under 37 CFR 1.75(c) is obviated by the above amendment. Claims 5 and 7 have been amended to remove multiple dependency.

Applicants respectfully submit that the present application is now in condition for allowance. Favorable reconsideration is respectfully requested. Should anything further be required to place the application in condition for allowance, the Examiner is requested to contact the undersigned by telephone.

Respectfully submitted,

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HEREWITH

IN THE SPECIFICATION

Please delete the paragraph beginning at page 3, line 8, and replace with the following.

--While the theoretical thermal conductivity of silica is approximately $2 \text{ Wm}^{-1}\text{K}^{-1}$, that of aluminum nitride is approximately $300 \text{ Wm}^{-1}\text{K}^{-1}$, so that a high degree of heat dissipation may be expected even in cases where the amount of aluminum nitride added is less than the amount of silica added. Specifically, if an aluminum nitride filler is present whose characteristics other than thermal characteristics, such as particle size distribution, degree of spherical shape and the like, are comparable to the characteristics of current silica fillers, there is a possibility that the thermal characteristics, viscosity and moldability can be simultaneously improved to an unprecedented extent. From this standpoint, attempts to replace "some part" of silica with an aluminum nitride powder have been published (for example, see Japanese Patent Application Laid-Open No. 9-183610/1997). At the current point in time, however, aluminum nitride powders which have the particle size (several microns to several tens of microns) required in a filler powder are manufactured mainly by the direct nitridation process, in which manufacture is accomplished by a pulverization process. Accordingly, such powders are non-spherical powders which have angular shapes,

and therefore suffer from the drawback of a conspicuously lowered viscosity and moldability.

The direct-nitridation is conventionally a batch type production, so that the productivity is very low. Accordingly, the simultaneous addition of a spherical silica powder is considered necessary, and the only method of use that has been possible is a method in which only a portion of the silica is replaced.--

Please delete the paragraph beginning at page 4, line 9, and replace with the following.

--The reduction nitridation (carbothermal-reaction) method in which a mixture of alumina and carbon is sintered in a nitrogen atmosphere also exists as an industrial manufacturing method alongside the direct nitridation method. In the case of the reduction nitridation method, in which no pulverization process is necessary, a powder with a relatively high degree of spherical shape can be manufactured. However, current reduction nitridation processes have been established mainly as processes for supplying the raw-material powders of sinters. Accordingly, such processes deal mainly with powders whose mean particle size is on the sub-micron order, and have not been devised so that powders that have a particle size on the order of ten-odd microns or greater, which are mainly required as filler powders, can easily be used. Furthermore, in the case of the reduction nitridation method which involves an endothermic reaction that is the exact opposite of the exothermic direct nitridation method, a heat treatment for a fixed time or longer in the high-temperature region of approximately 1500 to 1800°C is essential, and in cases where a raw-material powder of alumina or the like with a large particle size is prepared in order to manufacture a powder with a relatively large particle size such as a filler powder, it has not been confirmed that a reduction nitridation process can be proceeded efficiently by using an electric furnace alone. --

Please insert the following paragraph after page 5, line 7.

--Another conventional method of the carbothermal-reaction is to use simultaneously a reacting-agent in order to lower the temperature of endothermic reaction, and to produce a larger sized crystal. For example, an unagglomerated single crystal having a size of around 10 μm have been published through the carbothermal-reaction with using simultaneously a reacting-agent such as alkali metals, preferably Na_2O (for example, see USA Patent No. 5190738/1993). The powder would be improved the remained oxygen content and sufficient for reinforcement as a mechanical application; but not for LSI. The powder contains inherently the added alkali metal and derives a crucial lattice defect, which degrades the thermal conductivity. The remained alkali, especially soda (Na) element, is highly troublesome and hateful element for reacting easily to a constituent of LSI such as silicon. Besides, the carbothermal-reactions are conventionally batch type production, so that the productivity is very low.--

Please delete the paragraph beginning at page 5, line 21, and replace with the following.

--Specifically, in the cases of the three main existing methods for manufacturing aluminum nitride powders, there are the following problems, that are (1) the particle size is satisfactory but the desired shape and productivity cannot be obtained in the case of the direct nitridation method, (2) the degree of spherical shape is satisfactory but the desired particle [size cannot be obtained] size, purity, and productivity cannot be sufficient in the case of the reduction nitridation method, and (3) the desired particle size cannot be obtained in the case

of conventional vapor phase synthesis methods, which indicate that, at the current point in time, it is impossible to satisfy both particle size and shape requirements.--

IN THE CLAIMS

Please amend the claims as follows:

--1. (Amended) A flame synthesized aluminum nitride filler-powder [containing] comprising elements Al, O and N, or [containing] elements Al and N, while not containing any other elements selected from an alkali metal, wherein [characterized in that] the particle size of the powder is [included within the range of] from 0.001 to 500 μm , the mean particle size thereof is [within the range of] from 0.1 to 100 μm , the external shape of the particles is spherical, and the powder is manufactured continuously, not in a batch type production, by using as a raw material powder consisting of element Al, or a mixture of a powder consisting of elements Al and O and a powder consisting of element C in a gas phase in the presence of a flame.

3. (Amended) The powder according to claim 1, wherein the raw material is a powder consisting of element Al whose particle size is [included within the range of] from 0.01 to 500 μm , and a nitridation reaction is proceeded by using a flame in the presence of nitrogen, ammonia or an inert gas.

4. (Amended) The powder according to claim 1, wherein the raw material is a mixture of a powder consisting of elements Al and O and a powder consisting of element C whose respective particle sizes are [included within the range of] from 0.001 to 500 μm , and

a nitridation reaction is proceeded by using a flame in the presence of nitrogen, ammonia or an inert gas.

5. (Amended) [The] A powder prepared by [the step of,]

subjecting the powder [defined in any of claims] according to Claim 1 [through 4] to a heat treatment either continuously or intermittently in [the] a temperature range of from 500 to 10,000°C in the presence of air, nitrogen, ammonia or an inert gas, or in a vacuum state, by using a flame or an apparatus that is capable of applying a high temperature to the powder.

7. (Amended) A raw-material powder [(filler)] consisting of the powder [defined in any of claims] according to Claim 1 [through 5 containing] comprising elements Al, O and N or a powder [containing] comprising elements Al and N, [characterized in that] wherein the powder is used as a raw-material powder [(filler)] in a composite material system in which a powder [composed] comprising of inorganic materials is to be filled in a resin type raw material [composed] comprising of organic materials.--

--Claims 10-20 are new.--